Review MS No: acp-2012-310 : Atmospheric controls of surface incident solar radiation. K. Wang et al.

This ambitious study relates changes in mean monthly and decadal values of sunshine duration measured at over 1000 stations between 1982 and 2008 to changes in global radiation, cloud cover and aerosol optical depth in an attempt to assign causes for the observed changes. It concludes that cloud cover controls variation on monthly time scales whereas aerosols are the major factor determining decadal variability.

Unfortunately the methods used and the findings derived are not clearly presented so that substantial revision is required before publication of this manuscript can be recommended.

GENERAL COMMENTS Changes in cloud cover and aerosol load both influence global radiation but their interaction, the important part that aerosols play in the formation of clouds and in determining their radiative characteristics, makes it difficult to separate their roles: this complicating interaction is not discussed in the paper. Neither is it explained how cloud cover can control global radiation on a monthly time scale without influencing it on a decadal basis nor how aerosols can exert a control on a decadal time scale without influencing monthly values.

A general comment based on Ockham's Razor (-*Entities are not to be multiplied without necessity-)* applies to two specific points: the symbols used and the literature cited. Many years ago the World Meteorological Organization in its Guide to Instruments and Methods of Observation recommended the nomenclature and symbols to be used for sunshine duration and global radiation; there is no reason for the authors not to use them.

The authors frequently cite recent publications, often their own, to document facts clearly established many years ago; an example is the close relationship between sunshine duration and global radiation established by Kimball in 1919 and Angstrom in 1924. By contrast the extensive literature dealing with quadratic forms of this relationship, reviewed by Akinogle in 2008, is ignored despite their relevance to this study.

SPECIFIC COMMENTS

p.14013 line 4 This early reference is to global radiation under clear sky conditions, i.e R_c **not** R_s as defined here which is now used after Prescott's modification for all sky conditions.

p. 14013 line 9- p.14014 line 4. Unclear why Yang's 2006 study is presented here and what is its relevance to this study. Where does the R_c data come from?

p.14014 line 9. Unclear; the basis for the statement concerning relative quality of data needs to be given.

p. 14015 lines 6-19. Unclear, what does *this analysis* refer to? The statistics of the relationships presented in Figs. 2 and 3 are needed.

p. 14016 lines 9-17. Unclear, the Chinese radiation data is clearly not reliable before the network was upgraded and therefore should not be used in any way.

p. 14017 lines 1-2. Unclear what is the basis for the *poor agreements* as the reference cited reports a correlation coefficient of 0.926 and a root mean square error of 5% for mean annual values of global radiation estimated from a linear regression on annual sunshine duration.

line 7. Not so, Fig. 1a shows the limited global coverage of sunshine duration measurements.

lines 15-16. Unclear basis for division.

p. 14018 lines 5-12. Unclear exactly what data used. The relationship between relative sunshine duration and cloud cover has been documented on a diurnal, daily, weekly and monthly basis and there is some evidence that this is so for annual time scale as is logical to expect.

line 14. No correlations are presented in Fig. 11

p.14019 lines 9-10. Was the data pre-whitened before applying the Mann-Kendall test? As less than half of the stations had significant trends these merged results are unconvincing.

p.14021 line 1. 1982-2002 hardly constitutes *a long term series.*

lines 15-20. Unclear and unconvincing.

p. 14026 Table 1. Table heading not clear, if the 6^{th}, 7^{th} and 8^{th} columns represent the statistics of linear regressions of estimated on measured global radiation the very high correlation coefficients contrast with the significant bias and standard deviation terms. They are particularly questionable from China if the early, unreliable pyranometer data was used. The anomalies correlated are not defined, their bias is not shown and it is unclear what the last column refers to.

p. 14035 Fig. 6 Linear trends cannot be derived statistically from five-year smoothed data and are in any case obviously inappropriate for the time series shown.

p. 14036 Fig. 7 Clearly shows that the earlier Chinese pyranometer data should not be used.

p.14037 Fig. 8 Unclear what *baseline stations* means. Did the pyranometers used differ from the rest of the Chinese network?

p.14038 Fig. 9 Basis for division into six regions unclear.

p. 14039 Fig. 10 This figure would be much more informative if cloud cover fractions and not cloud cover fraction anomalies were correlated and their distribution plotted. Information is needed on the source of the data used and which sites had low and statistically non significant correlations.

p.14040 Fig. 11 Caption very unclear

p.14041 Fig. 12 Last sentence of caption misleading; correlation should not be made with data that is not independent such as the five-year smoothed data used here. Even if independent data was used the fact that at nearly half of the stations changes in AOD accounted for less than 25% of the changes in global radiation argues against the claim made in the last line. Finally if all correlations were carried out with independent data, were statistically significant and had coefficients of determination of $R^2 = 1.00$ -*correlation is no proof of causation.*

p.14042 Fig. 13 Unclear